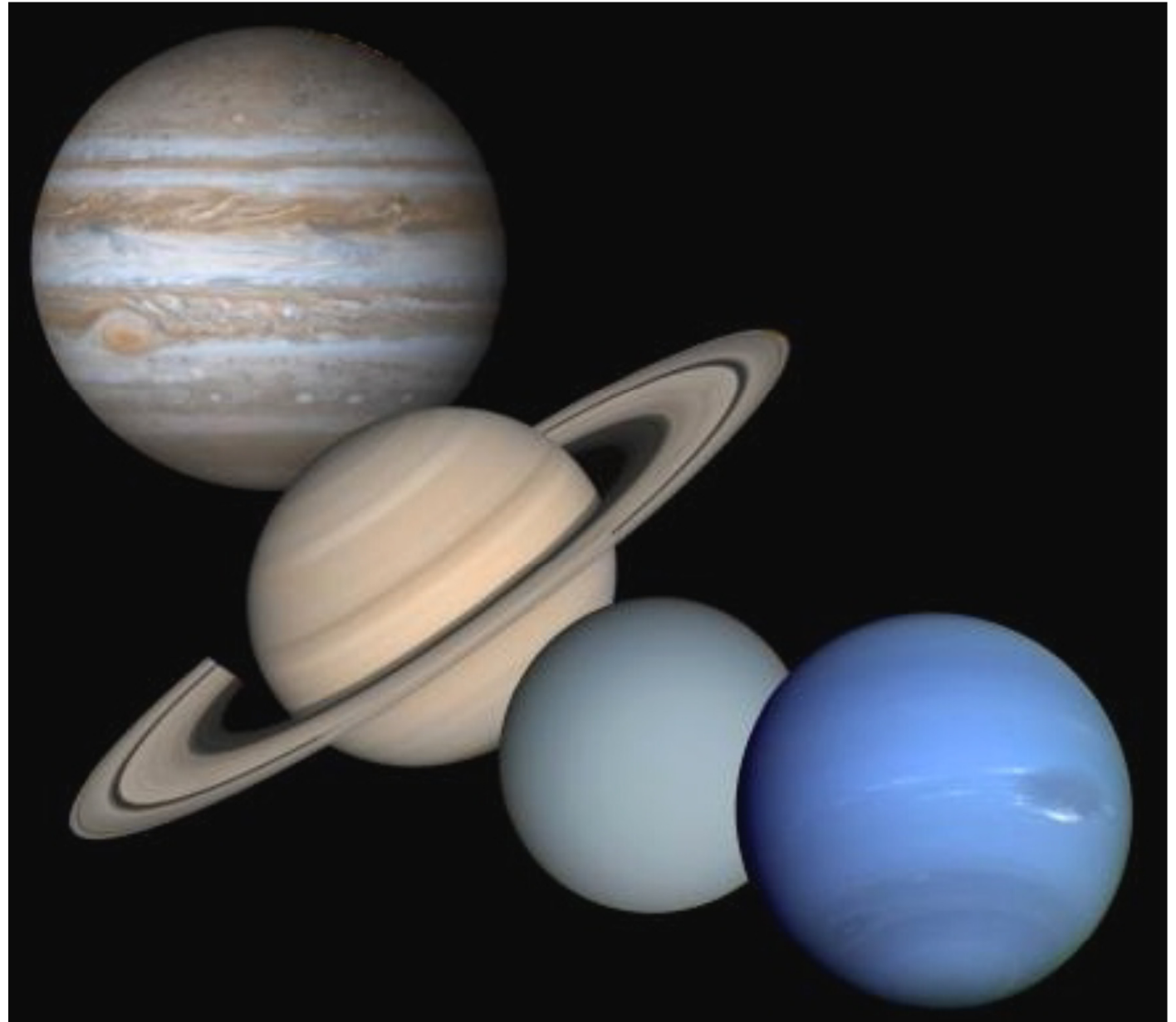


# Giant Planets: Big Questions

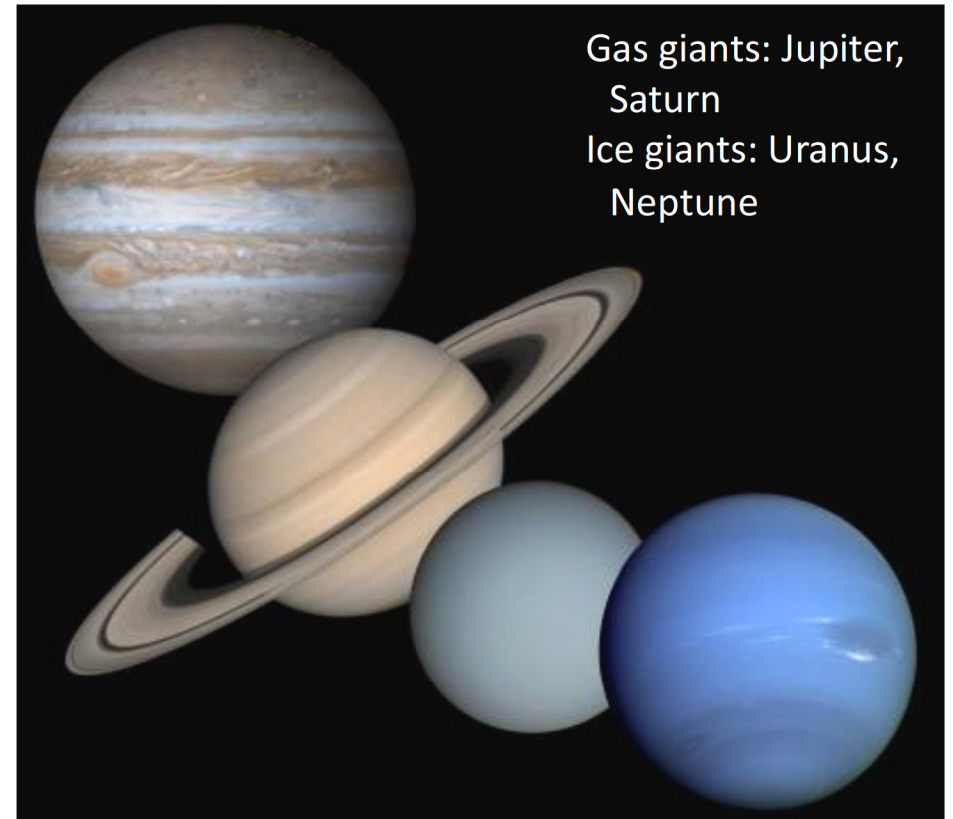
Joseph Lazio  
Jet Propulsion  
Laboratory,  
California Institute  
of Technology

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Government sponsorship  
acknowledged



# Giant Planets: Big Questions

- How long did it take for the giant planets to form?
- How did the formation of the gas giants differ from the ice giants?
- What is the history of water across the solar system?



- What processes shape, and have shaped, the current solar system?
- What does our solar system tell us about extrasolar planetary systems, and vice versa?

# Juno Mission Overview

**Science Objective:** Improve our understanding of giant planet formation and evolution by studying Jupiter's origin, interior structure, atmospheric composition and dynamics, and magnetosphere

**Salient Features:**

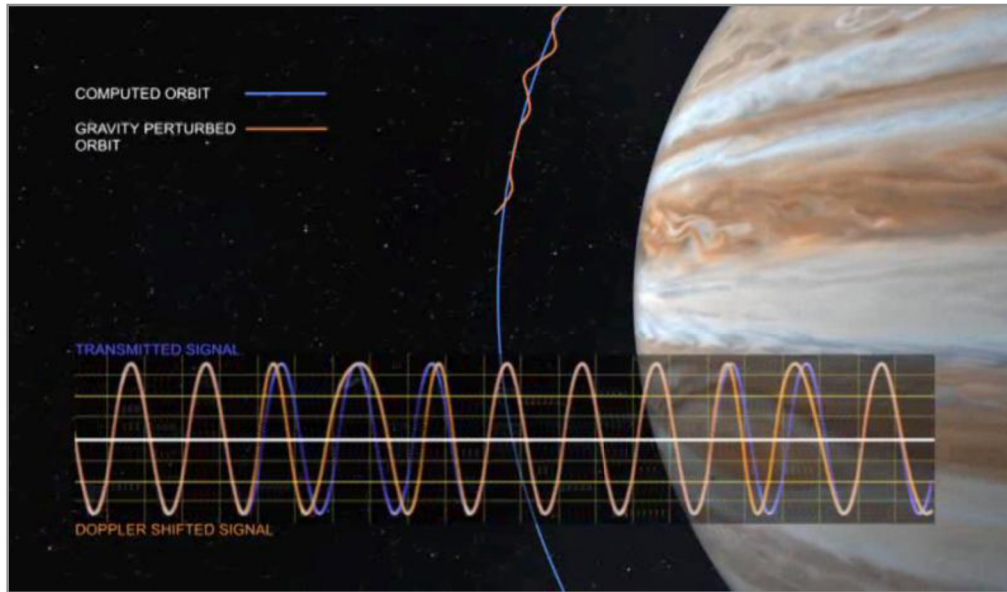
- Eight science instruments to conduct gravity, magnetic and atmospheric investigations, plus a camera for education and public outreach
- Polar orbiter spacecraft launched 2011 August 5
  - 5-year cruise to Jupiter, arriving 2016 July
  - About 1 year at Jupiter, ending with de-orbit into Jupiter in 2017
- First solar-powered mission to Jupiter
- Elliptical 11-day orbit swings below radiation belts to minimize radiation exposure

**Principal Investigator: Scott Bolton** (Southwest Research Institute)





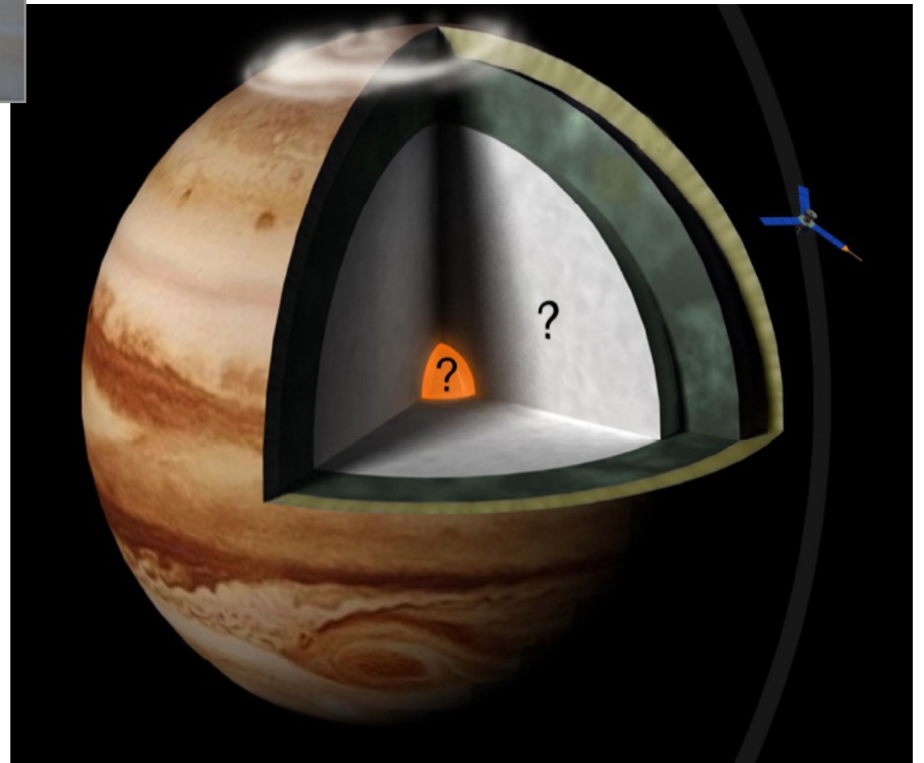
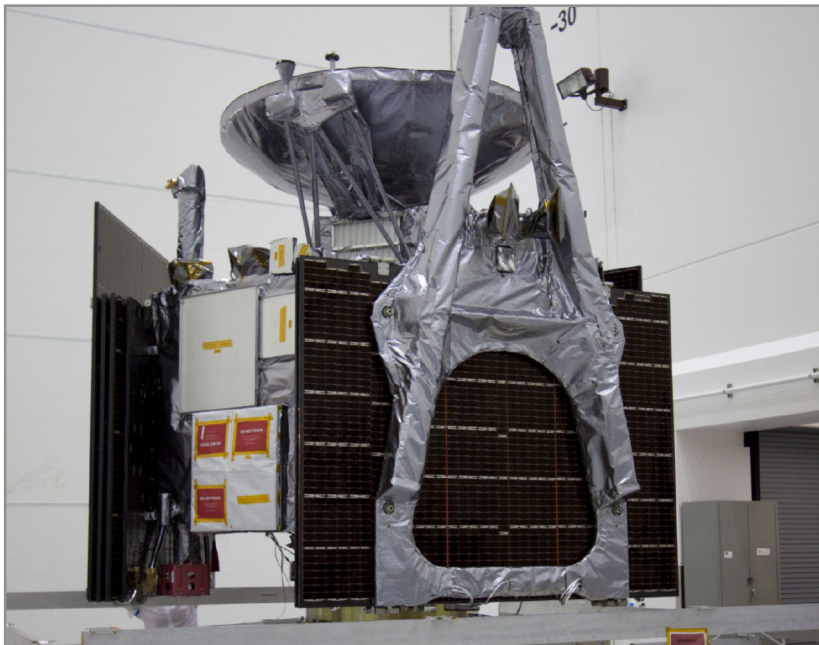
# Mapping Jupiter's Gravity



## GRAVITY SCIENCE & MAGNETOMETERS

Tracking changes in Juno's velocity reveals Jupiter's gravity (and therefore the planet's interior).

- X- and Ka-band transponders on spacecraft and Deep Space Network ground station



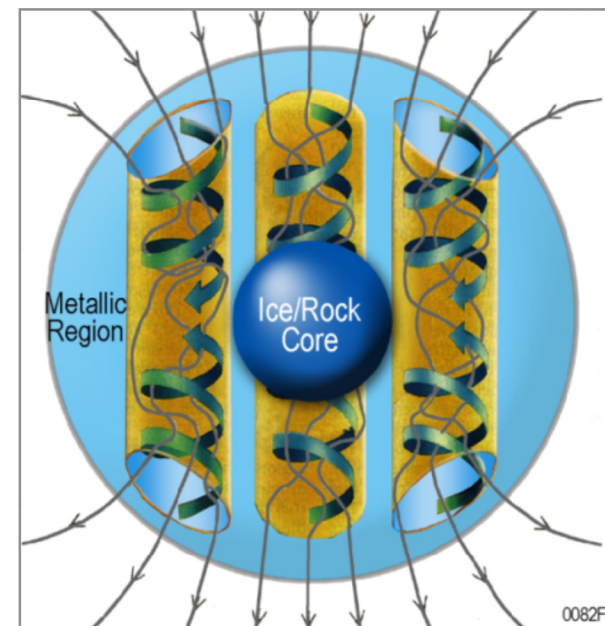
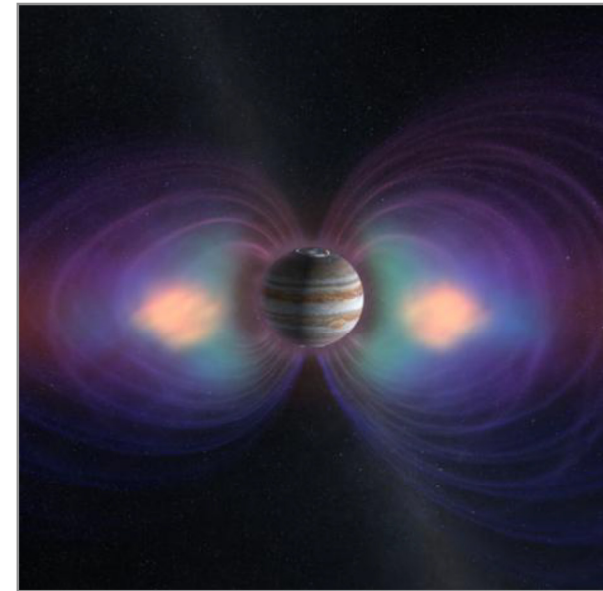
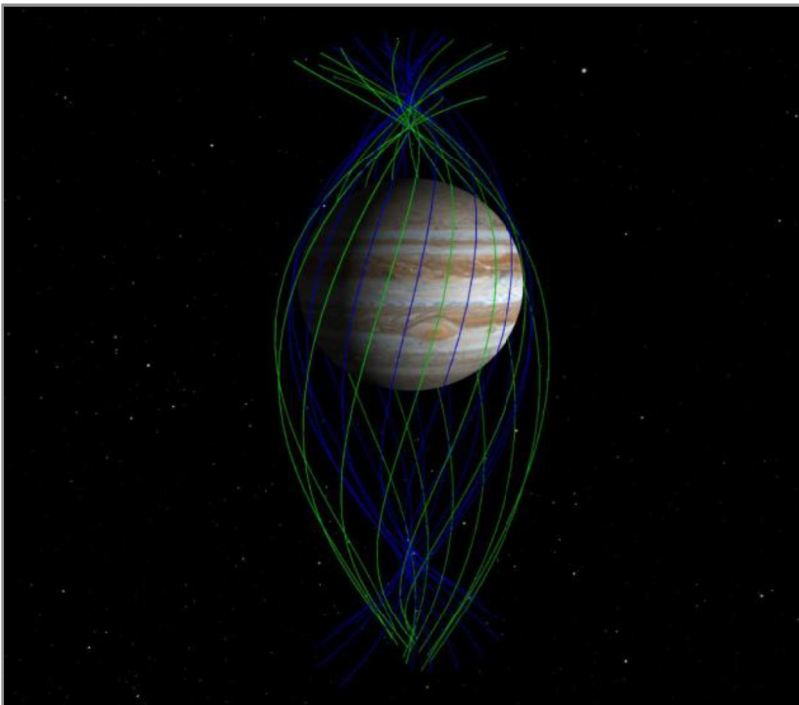


# Jupiter's Magnetic Field

## GRAVITY SCIENCE & MAGNETOMETERS

Jupiter's magnetic field lets us probe deep inside the planet.

Juno's polar orbit provides complete mapping of planet's powerful magnetic field.

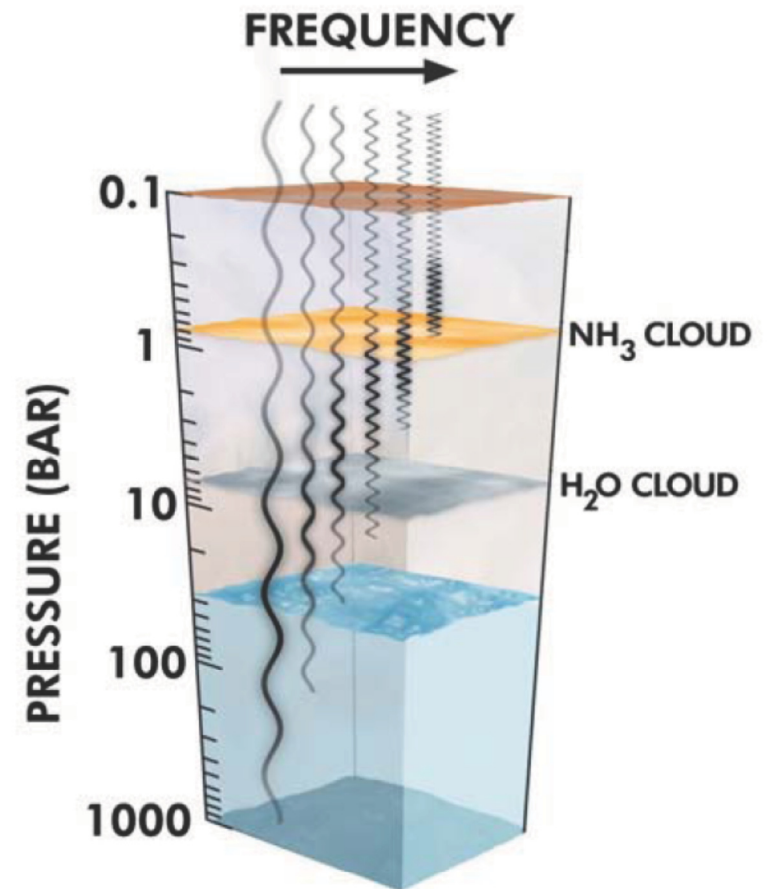
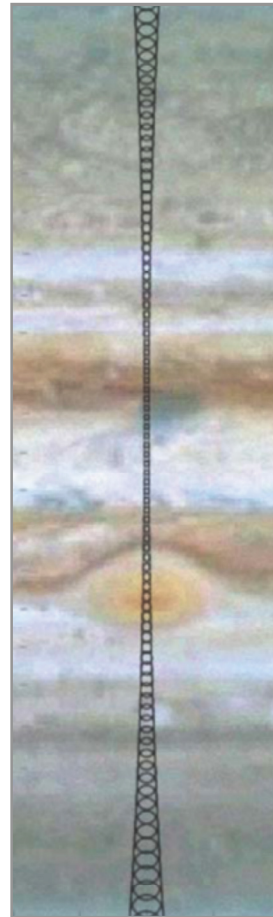


# Sensing the Deep Atmosphere

## MICROWAVE RADIOMETER

Measure heat radiating from the atmosphere to as deep as 1000 atmospheres pressure (~ 500–600 km below the visible cloud tops).

Determines water and ammonia abundances in the atmosphere all over the planet



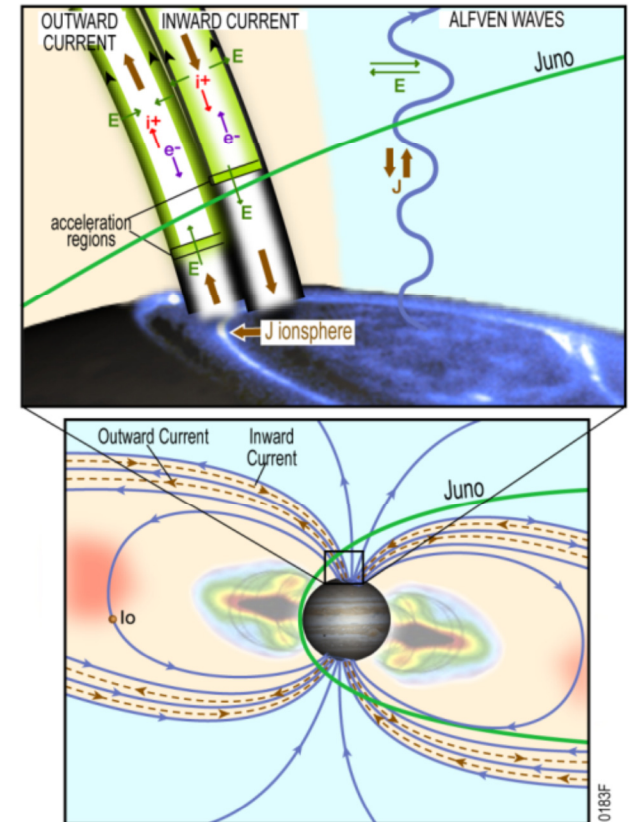
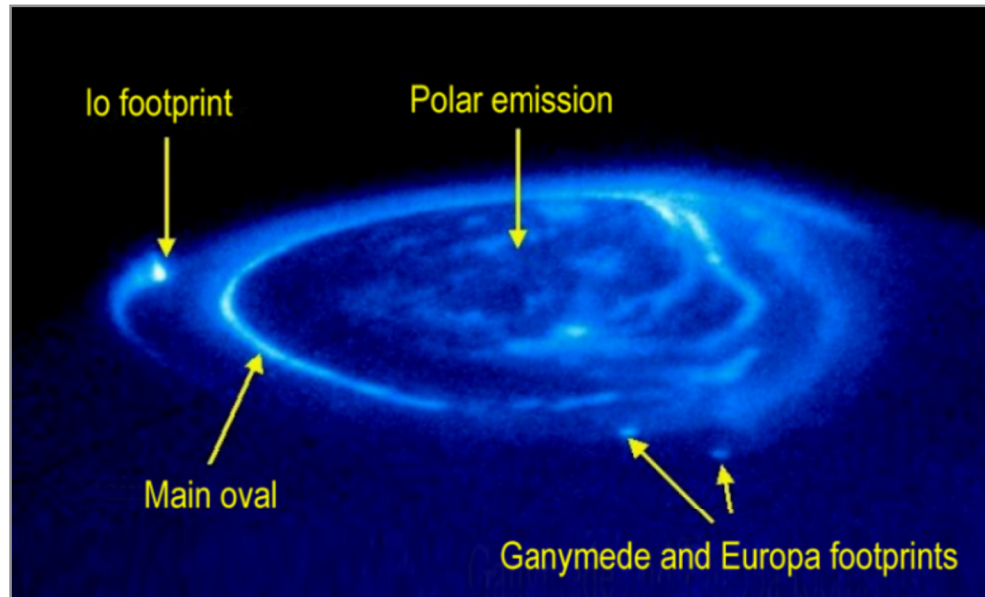


# Exploring the Polar Magnetic Field

## JEDI, JADE & WAVES

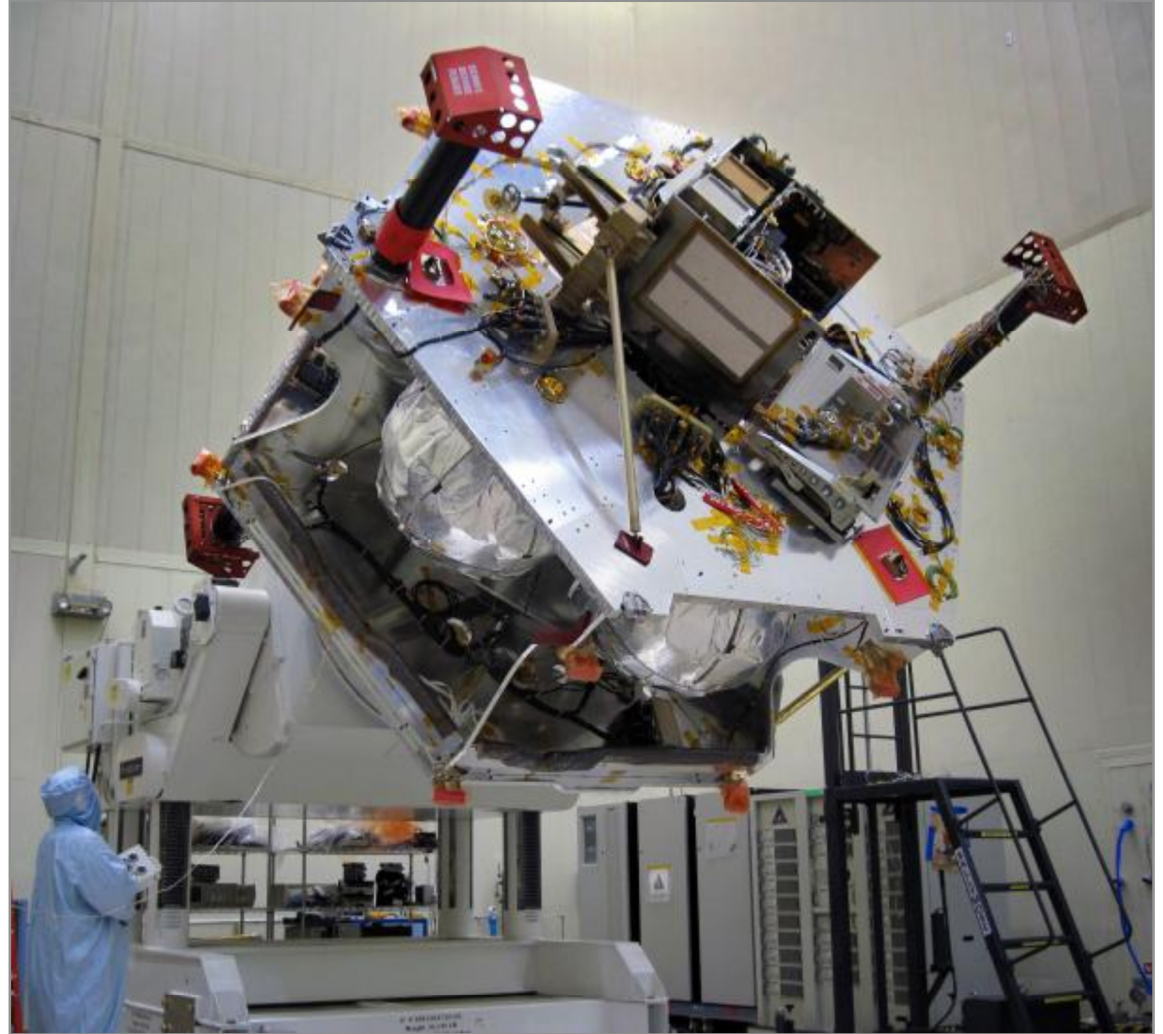
Jupiter's magnetic field near the planet's poles is a completely unexplored region!

Sample electric fields, radio waves, and particles around Jupiter to determine how the magnetic field inside the planet is connected to the atmosphere and magnetosphere, and especially the auroras (northern and southern lights)



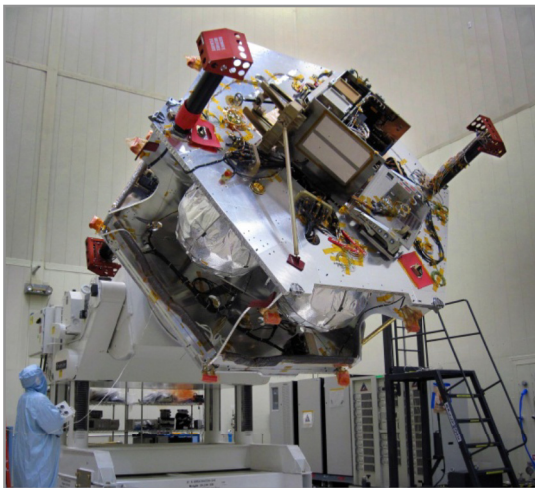
# Juno Spacecraft

## Key Component: Vault



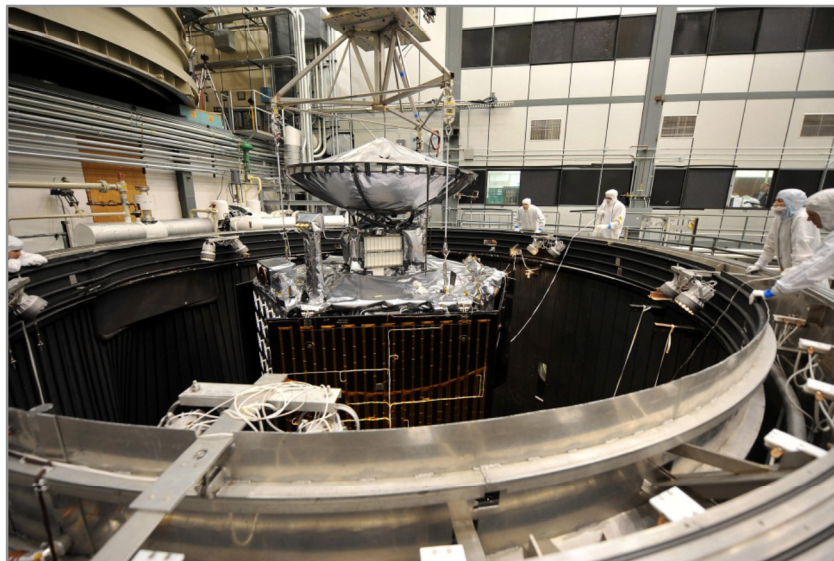


# Preparations for Launch





# Preparations for Launch





# Preparations for Launch





# Liftoff!

## 2011 August 5



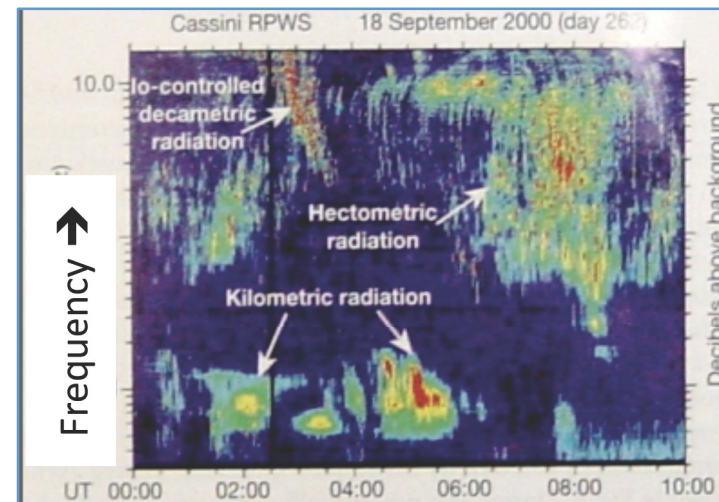
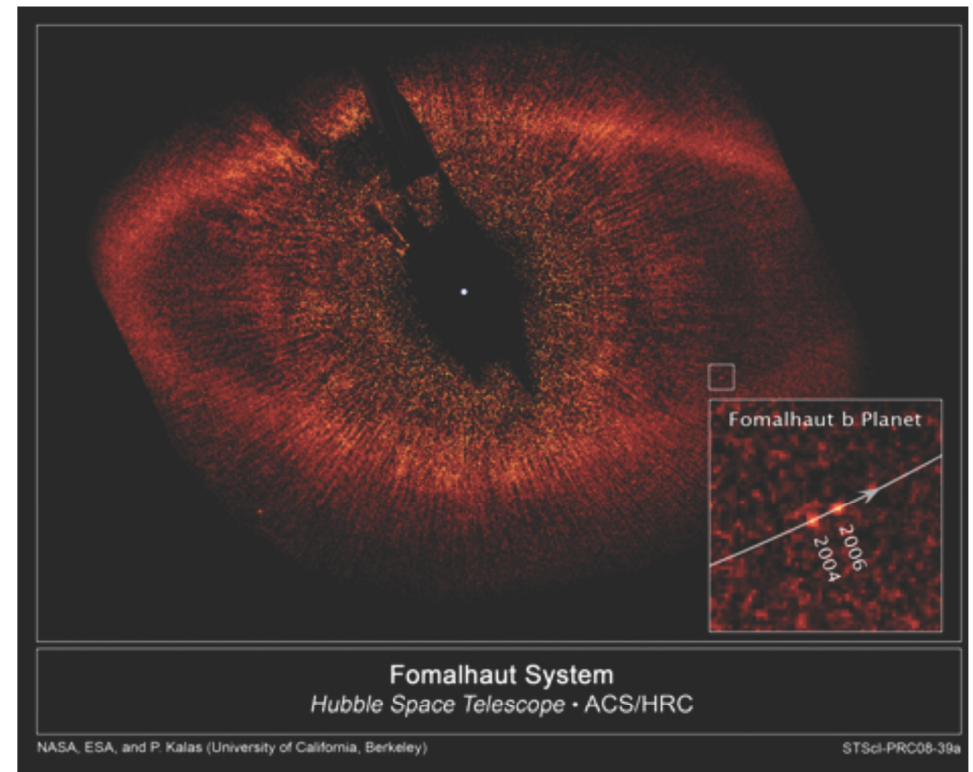


# Extrasolar Planets

- Hundreds of planets known outside the solar system
- Most detected only by their gravitational effects on their hosts stars

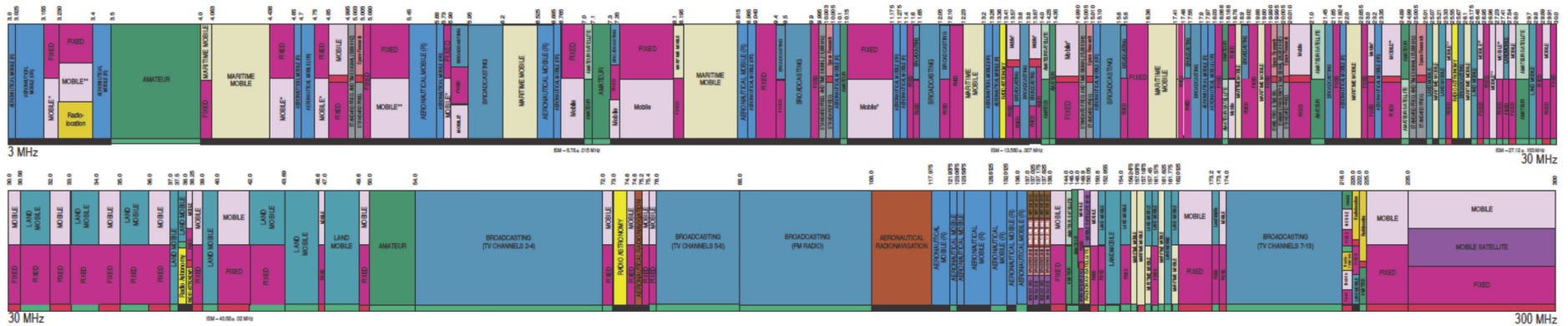
Fomalhaut b is the **exception!**

- Jupiter emits radio radiation, due to its **magnetic field**  
... below 40 MHz
- Laboratories for mutual understanding
  - Jupiter helps us understand extrasolar planets
  - Extrasolar planets help us understand our solar system



Jovian  
radio  
emissions  
(detected  
by *Cassini*  
spacecraft)

# Radio Astronomy Service and Extrasolar Planets



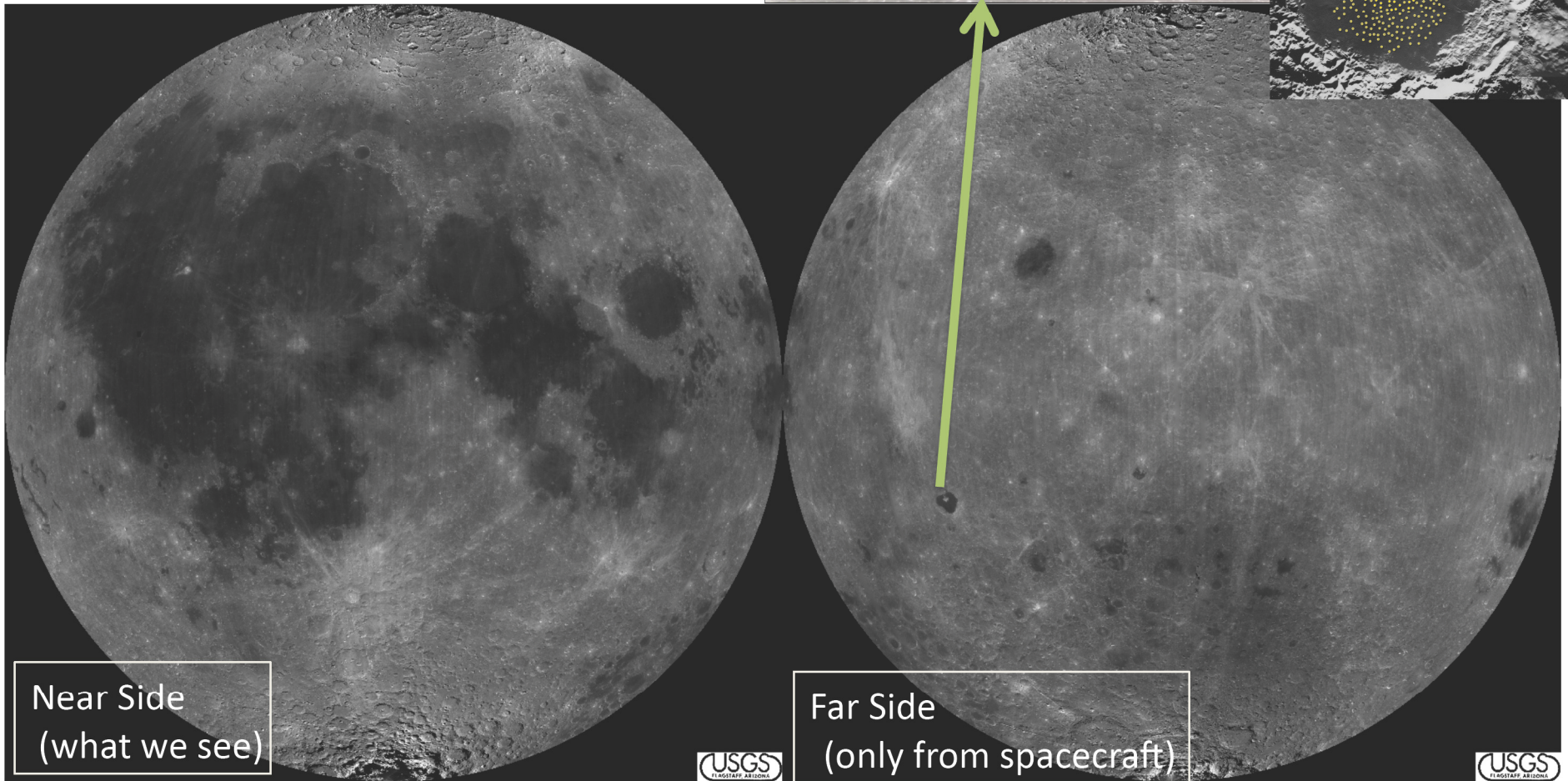
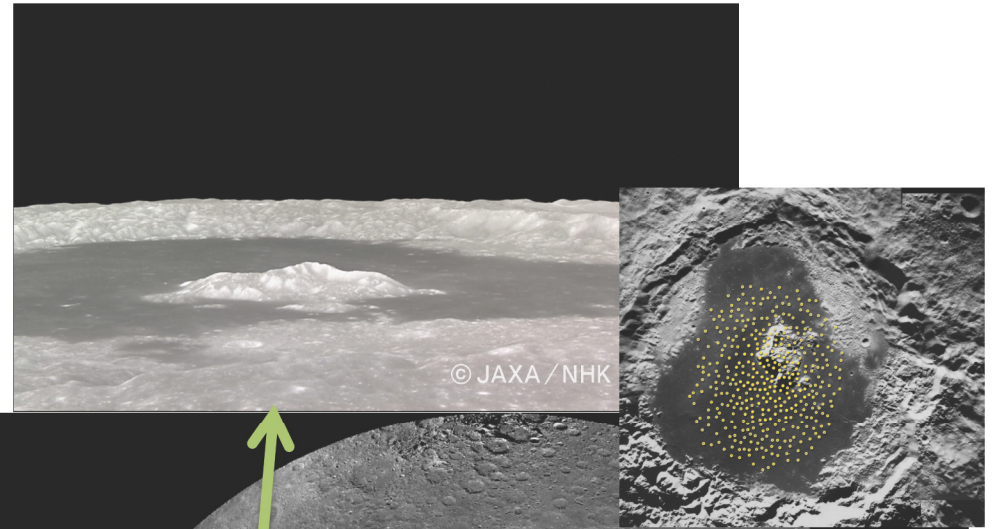
## Radio astronomy service allocations

- 73 MHz–74.6 MHz
- [Jupiter emission shuts off above about 40 MHz.]
- 37.5 MHz–38.25 MHz
- 25.55 MHz–25.67 MHz
- 13.36 MHz–13.41 MHz





# Radio Telescope in Shielded Zone of the Moon ITU-R RA.479



Near Side  
(what we see)

Far Side  
(only from spacecraft)

# Jupiter, Extrasolar Planets, and the Radio Spectrum

A composite image featuring the Juno spacecraft in the foreground, orbiting the planet Jupiter. The spacecraft's solar panels and antenna are visible against the backdrop of Jupiter's characteristic orange and white bands and the Great Red Spot. The background is the deep black of space.

Understanding Jupiter and the other giant planets, our solar system as a whole, and extrasolar planets requires

- Communication with planetary spacecraft
- Telescopes on the ground operating below **150 MHz**
- Radio telescope in the Shielded Zone of the Moon (far side, below **150 MHz**) [potentially].

## Juno Frequency Bands

- E-S: 7145-7190 MHz, 34.2-34.7 GHz
- S-E: 8400-8450 MHz, 31.8-32.3 GHz